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Editorial

Internet of Things Learning and Teaching

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Introduction

The Internet of Things (IoT) is widely considered as the next step towards a digital society, where objects and people are interconnected and interact through communication networks. IoT not only has a huge social impact, but can also support employability and boost the competitiveness of companies. It is widely considered as one of the most important key drivers for the implementation of so-called Industry 4.0, and for the digital transformation of companies. Relevant impacts of this technology are expected in a wide range of sectors.

The rapid diffusion of IoT technologies has created an important educational challenge, namely, the need to train a large number of professionals able to design and manage a quickly evolving and complex ecosystem. Thus, an important research effort is being made in innovative technologies (simulators, virtual and remote labs, mobile apps, robotics, e-learning platforms, gamification, learning analytics, etc.) applied to innovative teaching practices.

This Special Issue focuses on all the technologies involved in improving the teaching and learning process of some of the IoT-related topics, such as sensors, devices, protocols, platforms, services and data analysis, among others.

This Special Issue of *Technologies* comprises five selected papers about different IoT learning- or teaching-related applications and studies. The first paper, by Nardis [1], presents a ThingSpeak-based indoor positioning platform for academic research on location-aware Internet of Things: ThingsLocate. This is an open-source solution for the indoor positioning of WiFi IoT devices developed on top of the ThingSpeak. It uses the received signal strength indicator (RSSI) to provide a user-friendly WiFi fingerprinting indoor positioning service for IoT devices. The authors present a proof-of-concept implementation of ThingsLocate in the context of graduate studies and academic research on indoor positioning for IoT. The main advantages that this system provides are as follows: (a) it avoids the need for a local positioning server and dedicated libraries for collecting and loading WiFi fingerprinting data, (b) it allows the easy development of new positioning algorithms thanks to the support of remote Matlab code execution offered by ThingSpeak, and (c) it makes available client-side scripts and apps for multiple devices. Assante et al. [2] introduced a remote laboratory for Internet of Energy training. This remote lab consists of a smart rural house, equipped with a measurement and control system, able to reproduce the real behavior of a smart microgrid with its several subsystems: energy storage systems, charging stations and renewable power generation plants. Trainers can have direct experience of the main concepts related to smart grids, renewable energy sources, electrochemical storage systems, and electric vehicles, through the use of the proposed tool managed by the web software interface. Tobarra et al. [3] also present a remote laboratory for IoT teaching. This paper provides a very interesting overview of the evolution of IoT remote laboratories developed by the authors. The authors validate the presented system by exploring the impact of using a set of IoT devices as a technological environment. The final aim is to analyze the effectiveness of the learning process in the context of cybersecurity. According to the results, the use of these systems increases student motivation, understood as increasing interactions with the learning materials. On the other hand, Kusmin [4] presents design-based research focusing on introducing IoT technologies to secondary education. The author introduces the "Smart School-house by means of IoT" project, the ultimate goal of which is using inquiry- and project-based learning methods when teaching natural and exact sciences to find solutions to real-life problems, and through a trialogical approach creating innovative teaching materials that would support these methods. Finally, Figueroa et al. [5] studied the security challenges of two broadly used IoT technologies such as RFID (radio frequency identification) and Bluetooth. This is of great importance, since organizations must invest in awareness-based education to support staff understanding and knowledge of Bluetooth technology. Therefore, the first line of defense is to provide an adequate level of knowledge for those who will deal with Bluetooth-enabled devices.

The articles published in this Special Issue present only some of the most important topics about IoT learning and teaching. However, the selected papers offer significant studies and promising environments.

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